CLAIMS

What is claimed is:

1. A system to log a wellbore, comprising:

a logging tool adapted to be deployed in a wellbore and including at least one fiber optic sensor;

a fiber optic line in optical communication with the fiber optic sensor; and

the fiber optic sensor adapted to transmit data on a real time basis through the fiber optic line.

2. The system of claim 1, wherein the data comprises at least one measurement of the wellbore environment.

3. The system of claim 1, wherein the data comprises status data from the logging tool.

4. The system of claim 1, wherein the fiber optic line is incorporated into a slickline.

5. The system of claim 4, wherein the logging tool is attached to the slickline.

6. The system of claim 1, wherein the fiber optic line is incorporated into a braided cable.

7. The system of claim 6, wherein the braided cable also includes at least one electrical conductor.

8. The system of claim 6, wherein the logging tool is attached to the braided cable.

9. The system of claim 1, wherein the fiber optic line is deployed within a conduit.

10. The system of claim 9, wherein an actuation signal is sent through the conduit to actuate at least one device located downhole.

11. The system of claim 10, wherein the actuation signal comprises a hydraulic signal.

12. The system of claim 11, wherein the at least one device comprises one of a packer, a shaped charge, a flow control valve, a sleeve valve, a ball valve, a sampler, a sensor, a pump, or a tractor.

13. The system of claim 9, wherein the conduit is a tube.

14. The system of claim 9, wherein the conduit is a coiled tubing.

15. The system of claim 9, wherein the conduit is deployed within a coiled tubing.

16. The system of claim 9, wherein the logging tool is attached to the conduit.

17. The system of claim 1, wherein the fiber optic line is deployed through a stuffing box installed on a wellhead.

18. The system of claim 17, wherein the stuffing box forms a seal with the fiber optic line.

19. The system of claim 1, wherein the fiber optic line is deployed from a reel located at a surface of the wellbore.

20. The system of claim 19, wherein the reel is located on a vehicle.

21. The system of claim 19, wherein the logging tool is deployed and retrieved multiple times in the same wellbore.

22. The system of claim 20, wherein the logging tool is deployed and retrieved from multiple wellbores.

23. The system of claim 19, further comprising:

an optical slip ring functionally associated with the reel and the fiber optic line;

an acquisition unit attached to the fiber optic line at the surface;

the optical slip ring adapted to allow the transmission of optic data to the static acquisition unit while the conduit and fiber optic line therein move on the reel in and out of the wellbore.

24. The system of claim 1, wherein the fiber optic line is optically connected to an acquisition unit adapted to receive the data.

25. The system of claim 24, wherein the acquisition unit processes the data.

26. The system of claim 9, wherein:

a transmitter is located at a surface of the wellbore;

a modulator is located downhole;

the transmitter transmits an optical signal to the modulator; and

the modulator modulates the optical signal so that the return optical signal is encoded with the data.

27. The system of claim 1, wherein:

a transmitter is located at a surface of the wellbore;

a modulator is located downhole;

the transmitter transmits an optical signal to the modulator; and

the modulator modulates the optical signal so that the return optical signal is encoded with the data.

28. The system of claim 1, wherein:

a transmitter is located downhole; and

the transmitter sending optical signals through the fiber optic line based on the readings of the at least one fiber optic sensor.

29. The system of claim 1, wherein the fiber optic sensor reflects a return optical signal back to an acquisition unit with the relevant measurement encoded therein.

30. The system of claim 1, wherein the fiber optic sensor comprises at least one of a temperature sensor, a pressure sensor, an acoustic sensor, a casing collar locator, a flow sensor, a chemical property sensor, a gamma ray tool, an optical fluid analyzer, a gyro tool, a water detection sensor, a gas detection sensor, an oil detection sensor, a differential pressure sensor, a spectrometer, an inclinometer, a relative bearing sensor, a distributed temperature sensor, a distributed strain sensor, a hydrophone, an accelerometer, a sonic tool, a resistivity sensor, or an induction sensor.

31. The system of claim 1, wherein the fiber optic line acts as a distributed temperature sensor.

32. The system of claim 1, wherein the fiber optic line acts as a distributed strain sensor.

33. The system of claim 1, wherein the fiber optic line acts as an acoustic array.

34. The system of claim 1, wherein a plurality of fiber optic lines are in optical communication with the logging tool.

35. The system of claim 1, wherein optical signals sent through the fiber optic line actuate at least one device located downhole.

36. The system of claim 35, wherein a photovoltaic converter receives the optical signal and enables the actuation of the at least one device.

37. The system of claim 35, wherein the at least one device comprises one of a packer, a shaped charge, a flow control valve, a sleeve valve, a ball valve, a sampler, a sensor, a pump, or a tractor.

38. The system of claim 1, wherein the fiber optic sensor comprises a piezoelectric material to apply strain on a portion of the fiber optic line.

39. The system of claim 38, wherein the fiber optic sensor comprises a fiber Bragg grating provided on the portion of the fiber optic line.

40. The system of claim 1, wherein the fiber optic sensor comprises a magneto-strictive coating on at least a portion of the fiber optic line.

41. The system of claim 40, wherein the fiber optic sensor comprises a magnet to generate a magnetic field to cause the magneto-strictive coating to apply strain on the at least a portion of the fiber optic line.

42. The system of claim 1, wherein the fiber optic sensor comprises a spinner rotatable in response to a well characteristic.

43. The system of claim 42, wherein the fiber optic sensor further comprises a magnet attached to rotate with the spinner, the magnet to induce electrical energy in a coil.

44. The system of claim 43, wherein the fiber optic sensor further comprises a piezoelectric material responsive to electrical energy from the coil to apply strain on a portion of the fiber optic line.

45. The system of claim 42, further comprising a mirror, wherein the spinner comprises an element having at least one opening, wherein rotation of the spinner causes the mirror to be intermittently exposed to light in the fiber optic line through the opening.

46. The system of claim 1, wherein the fiber optic sensor comprises one of a spectrometer and a refraction measurement device.

47. The system of claim 1, wherein the fiber optic sensor comprises one of a channel and chamber containing a fluid, light transmitted through the fiber optic line to pass through the one of the channel and chamber.

48. The system of claim 47, wherein the fiber optical sensor further comprises a first optical fiber segment on one side of the channel or chamber, an a second optical fiber segment on another side of the channel or chamber.

49. The system of claim 47, wherein the fiber optic sensor further comprises a reflector proximate the channel or chamber

50. The system of claim 1, wherein the fiber optic sensor comprises an inclinometer having a mass supported by plural optical fiber segments.

51. The system of claim 1, wherein the fiber optic sensor comprises a compass.

52. The system of claim 1, wherein the fiber optic sensor comprises a gamma ray detector.

53. The system of claim 52, wherein the gamma ray detector comprises a scintillating crystal and an element to convert light photons generated by the scintillating crystal to one of an optical signal and an electrical signal.

54. The system of claim 1, wherein the fiber optic sensor comprises resistivity electrodes.

55. The system of claim 54, wherein the fiber optic sensor comprises a piezoelectric element responsive to at least one of the resistivity electrodes to apply strain on a portion of the fiber optic line.

56. The system of claim 1, wherein the fiber optic sensor comprises an induction coil and a piezoelectric element responsive to electric voltage of the induction coil to apply strain on a portion of the fiber optic line.

57. The system of claim 1, further comprising:

a second fiber optic sensor coupled to the fiber optic line; and

wavelength division multiplexing elements to enable the fiber optic sensor to be responsive to optical signals of different wavelengths.

58. The system of claim 1, further comprising:

a second fiber optic sensor coupled at the fiber optic line; and

time division multiplexing elements to enable communication with the fiber optic sensors at different times.

59. The system of claim 1, further comprising:
a downhole modulator to modulate an optical signal in the fiber optic line.

60. The system of claim 59, wherein the modulator is an optical interferometer.

61. The system of claim 1, wherein the fiber optic line includes an end cut at a slanted angle.

62. The system of claim 59, wherein the modulator moves in relation to the fiber optic line to cause the modulation of the optical signal.

63. The system of claim 59, wherein the modulator comprises a piezoelectric element to apply strain on a portion of the fiber optic line.

64. A fiber optic flow sensor adapted to be disposed in a wellbore, comprising:
a fiber optic line carrying an optical signal;
a spinner adapted to spin when in contact with fluids flowing through the wellbore; and
a modulator functionally connected to the spinner, the modulator modulating the optical signal depending on the spinning of the spinner.

65. The sensor of claim 64, wherein the modulator is located on the spinner and the spinner and modulator are constructed so that the modulator becomes aligned with the fiber optic line at least once every revolution of the spinner.

66. The sensor of claim 65, wherein:
a pulse is reflected through the fiber optic line each time the modulator becomes aligned with the fiber optic line; and

an acquisition unit receives the reflected pulse and determines the velocity of the wellbore fluids based on the frequency of reception of the reflected pulses.

67. The sensor of claim 65, wherein the spinner includes a blade coupled to a disc.

68. The sensor of claim 67, wherein the blade is located external to the housing and the disc is located internal to the housing.

69. The sensor of claim 67, wherein the housing is sealed.

70. The sensor of claim 69, wherein the blade and the disc are magnetically coupled across the housing.

71. The sensor of claim 67, wherein the modulator is located on the disc.

72. The sensor of claim 71, wherein the modulator is located at a side of the disc.

73. The sensor of claim 64, wherein the optical signal is modulated by imparting a strain on the fiber optic line.

74. The sensor of claim 73, wherein the modulator comprises a fiber bragg grating incorporated on the fiber optic line.

75. The sensor of claim 73, further comprising:
a permanent magnet coupled to the spinner;
a coil attached to a housing; and
wherein the permanent magnet and the coil become magnetically connected as the spinner revolves.

76. The sensor of claim 75, wherein the magnetic connection generates a voltage that causes a piezoelectric material mechanically coupled to the fiber optic line to constrict and strain the fiber optic line.

77. A casing collar locator adapted to detect casing collars disposed in a wellbore, comprising:

a fiber optic line carrying an optical signal;

a magnetic device adapted to become magnetically connected to a casing collar as the magnetic device passes the casing collar;

a modulator that is functionally connected to the magnetic device;

wherein the optical signal is modulated by the modulator when the magnetic device passes the casing collar.

78. The locator of claim 77, wherein the modulator is an optical interferometer.

79. The locator of claim 77, wherein the magnetic device brings the modulator into alignment with the fiber optic line when the magnetic device passes a casing collar and the optical signal is modulated when the modulator is in alignment with the fiber optic line.

80. The locator of claim 79, wherein:

a pulse is reflected through the fiber optic line each time the modulator becomes aligned with the fiber optic line; and

an acquisition unit receives the reflected pulse and thereby identifies the detection of the casing collar.

81. The locator of claim 77, wherein the optical signal is modulated by imparting a strain on the fiber optic line.

82. The locator of claim 81, wherein the modulator comprises a fiber-bragg grating incorporated on the fiber optic line.

83. The locator of claim 81, wherein the magnetic device comprises a permanent magnet and a coil.

84. The locator of claim 81, wherein the magnetic connection generates a voltage that causes a piezoelectric material mechanically coupled to the fiber optic line to constrict and strain the fiber optic line.

85. The locator of claim 77, wherein the modulator moves in relation to the fiber optic line to cause the modulation of the optical signal.

86. The locator of claim 85, wherein the magnetic device comprises a permanent magnet and a moving magnet and the moving magnet moves in relation to the permanent magnet when the magnetic device passes the casing collar.

87. The locator of claim 86, wherein movement of the moving magnet causes the movement of the modulator in relation to the fiber optic line.

88. The locator of claim 87, wherein the moving magnet is biased to a stationary position by a spring.

89. The locator of claim 87, wherein the modulator comprises a component having alternately placed black and white lines.

90. A method of logging a wellbore, comprising:

deploying a logging tool in a wellbore that includes at least one fiber optic sensor;

sending data from the fiber optic sensor; and

transmitting the data to a surface of the wellbore on a real time basis through a fiber optic line that is in optical communication with the fiber optic sensor.

91. The method of claim 90, wherein the data comprises at least one measurement of the wellbore environment.

92. The method of claim 90, wherein the data comprises status of the logging tool.

93. The method of claim 90, further comprising deploying the fiber optic line within one of a slickline or a braided cable.

94. The method of claim 92, further comprising deploying the fiber optic line within a conduit.

95. The method of claim 94, further comprising sending an actuation signal through the conduit to actuate at least one device located downhole.

96. The method of claim 95, wherein the actuation signal comprises a hydraulic signal.

97. The method of claim 96, wherein the at least one device comprises one of a packer, a shaped charge, a flow control valve, a sleeve valve, a ball valve, a sampler, a sensor, a pump, or a tractor.

98. The method of claim 94, wherein the conduit is a tube.

99. The method of claim 94, wherein the conduit is a coiled tubing.

100. The method of claim 94, further comprising attaching the logging tool to the conduit.

101. The method of claim 94, further comprising deploying the conduit from a reel located at a surface of the wellbore.

102. The method of claim 101, further comprising positioning the reel on a vehicle.

103. The method of claim 90, further comprising deploying and retrieving the logging tool multiple times in the same wellbore.

104. The method of claim 90, further comprising receiving the data in an acquisition unit that is optically connected to the fiber optic line.

105. The method of claim 90, further comprising:

transmitting an optical signal from a transmitter located at a surface of the wellbore to a modulator located downhole; and

modulating the optical signal so that the return optical signal is etched with the data.

106. The method of claim 90, further comprising reflecting a return optical signal back to an acquisition unit with the relevant measurement encoded therein.

107. The method of claim 90, wherein the fiber optic sensor comprises at least one of a temperature sensor, a pressure sensor, an acoustic sensor, a casing collar locator, a flow sensor, a chemical property sensor, a gamma ray tool, an optical fluid analyzer, a gyro tool, a water detection sensor, a gas detection sensor, an oil detection sensor, a differential pressure sensor, a spectrometer, an inclinometer, a relative bearing sensor, a distributed temperature sensor, a distributed strain sensor, a hydrophone, an accelerometer, a sonic tool, a resistivity sensor, or an induction sensor.

108. The method of claim 90, wherein the fiber optic line acts as a distributed temperature sensor.

109. The method of claim 108, wherein the fiber optic line acts as a distributed strain sensor.

110. The method of claim 90, wherein the fiber optic line acts as an acoustic array.

111. The method of claim 90, wherein a plurality of fiber optic lines are in optical communication with the logging tool.

112. The method of claim 90, further comprising sending an optical signal through the fiber optic line actuate at least one device located downhole.

113. The method of claim 112, wherein the at least one device comprises one of a packer, a shaped charge, a flow control valve, a sleeve valve, a ball valve, a sampler, a sensor, a pump, or a tractor.

114. The method of claim 105, wherein the modulating comprises imparting a strain on the fiber optic line.

115. The method of claim 105, wherein the modulating comprises changing an optical path in an optical interferometer.

116. The method of claim 105, wherein the modulating comprises moving a modulator in relation to the fiber optic line.

117. A method to calculate the flow of fluid within a wellbore, comprising:

providing a spinner adapted to spin when in contact with fluids flowing through the wellbore; and

modulating an optical signal transmitted through a fiber optic line depending on the spinning of the spinner.

118. The method of claim 117, wherein the modulating step comprises aligning a modulator with the fiber optic line once every revolution of the spinner.

119. The method of claim 118, further comprising determining the velocity of the wellbore fluids based on the frequency of modulations.

120. The method of claim 117, wherein the modulating step comprises imparting a strain on the fiber optic line.

121. The method of claim 120, wherein the imparting step comprises:

creating a magnetic connection related to the revolution of the spinner; and generating a voltage that causes a piezoelectric material mechanically coupled to the fiber optic line to constrict and strain the fiber optic line.

122. A method for identifying the location of casing collars disposed in a wellbore, comprising:

providing a magnetic device adapted to become magnetically connected to a casing collar as the magnetic device passes the casing collar; and

modulating an optical signal transmitted through a fiber optic line when the magnetic device passes the casing collar.

123. The method of claim 122, wherein the modulating step comprises aligning a modulator with the fiber optic line when the magnetic device passes the casing collar.

124. The method of claim 122, wherein the modulating step comprises imparting a strain on the fiber optic line.

125. The method of claim 124, wherein the imparting step comprises:

creating a magnetic connection between the magnetic device and the casing collar when the magnetic device passes the casing collar; and

generating a voltage that causes a piezoelectric material mechanically coupled to the fiber optic line to constrict and strain the fiber optic line.

126. The method of claim 122, wherein the modulating step comprises moving a modulator in relation to the fiber optic line.

127. The method of claim 126, wherein the moving step comprises moving a moving magnet in relation to a permanent magnet when the magnetic device passes the casing collar.

128. The method of claim 127, further comprising biasing the moving magnet to stationary position by use of spring.

129. A system for use in a subterranean well, comprising:

a conduit extending from a surface of a well towards a bottom of the well;

a fiber optic line located within the conduit;

the conduit adapted to transmit an actuation signal to actuate at least one device located downhole;

the fiber optic line adapted to transmit an optical signal; and

wherein the conduit transmits the actuation signal and the fiber optic line transmits the optical signal at the same time.

130. The system of claim 129, wherein the actuation signal comprises a hydraulic signal.

131. The system of claim 129, wherein the optical signal comprises a signal to actuate at least one device located downhole.

132. The system of claim 129, wherein the optical signal comprises data.

133. A method for transmitting signals in a subterranean well, comprising:

providing a conduit that extends from a surface of a well towards a bottom of the well;

providing a fiber optic line within the conduit;

transmitting an actuation signal through the conduit to actuate at least one device located downhole; and

transmitting an optical signal through the fiber optic line at the same time as the transmitting an actuation signal step.

134. A system comprising:

a fiber optic line; and

a device responsive to optical signals in the fiber optic line, the device comprising:

a valve responsive to the optical signals; and

a chamber, the valve to control communication of fluid between the chamber and a wellbore environment.

135. The system of claim 134, wherein the device comprises a tracer injection device.

136. The system of claim 134, wherein the device comprises a sampler device.

137. The system of claim 136, wherein the sampler device comprises a bottle containing a vaccum prior to opening of the valve.

138. A system to log a wellbore, comprising:

a tool adapted to be deployed in a wellbore;

a fiber optic line in optical communication with the tool; and

the tool comprising at least one of a temperature sensor, a pressure sensor, an acoustic sensor, a casing collar locator, a flow sensor, a chemical property sensor, a gamma ray tool, an optical fluid analyzer, a gyro tool, a water detection sensor, a gas detection sensor, an oil detection sensor, a differential pressure sensor, a spectrometer, an inclinometer, a relative bearing sensor, a distributed temperature sensor, a distributed strain sensor, a hydrophone, an accelerometer, a sonic tool, a resistivity sensor, an induction sensor, a spectrometer, a refraction measurement device, a tracer injection tool, a packer, a shaped charge, a flow control valve, a sleeve valve, a ball valve, a sampler, a sensor, a pump, and a tractor.